

Lake States
Misc



MORTALITY IN SELECTIVELY CUT NORTHERN HARDWOODS

by

F. H. Eyre and R. H. Blythe, Jr.

Lake States Forest Experiment Station^{1/}

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^{1/} Maintained by the U. S. Department of Agriculture at St. Paul, Minnesota in cooperation with the University of Minnesota.

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The forest provisions of Article X of the Lumber Code transferred selective logging from the realm of experimentation and theoretical discussion and brought it nearer to actual woods practice. Some of the conclusions regarding the advantages of selective logging, which in the past provoked no controversies, are now being put to a searching and severe test of practicability. This is a good sign and unless selective logging can stand up under this test, it will not become the generally adopted woods practice in the northern hardwoods.

This paper will be limited to the discussion of one phase, viz : mortality of trees left after selective logging. Some claims have been made that the mortality of the residual stand in selective logging is so great as to make selective cutting entirely impracticable. There are so few accurate observations, however, on any large scale, as to the effect of selective logging on the growth and mortality of the remaining stand, that it may be worth while to present

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here the results obtained at our Upper Peninsula Branch Station.

There we have conducted cutting experiments for the past seven years. In the fall of 1926, we started to test different degrees of partial cutting in northern hardwood forests, such as are characteristic of the Upper Peninsula and northeastern Wisconsin.^{1/} We have cut over since then about 120 acres under six different degrees of selective logging in the hardwood type. To bring out the contrast, we have also made clear cuttings, totaling 10 acres, at one extreme and have carried on observations on about 50 acres of virgin forest at the other extreme. We have, therefore, the entire range from clear cutting to virgin conditions. The amounts removed under the different degrees of cutting during the period 1926 to 1928 are given in Table 1.

On each of these cuttings, sample plots of one to four acres have been established. These are measured at five-year intervals to determine growth and mortality. Such records are now available for six methods of cutting. While these permanent sample plots may be sufficient to determine growth, it was felt that for determining mortality they were too small. For this reason, beginning with 1929, or 5 years ago, mortality was studied over larger areas. The entire cut-over area, and in addition 50 acres of virgin forest, were covered by a 100 per cent tally of mortality. This has been repeated each year. Altogether, 104 acres have been under observation for 5 years for the study of the single factor, mortality.

^{1/} In the stands in which cuttings were made, sugar maple comprises 81 per cent of the number of trees and 87 per cent of the merchantable volume. Yellow birch, second in importance, makes up only 5 per cent of the number of trees. The balance is a mixture of some seven species of hardwoods and softwoods.

TABLE I.

DIFFERENT DEGREES OF CUTTING
Upper Peninsula Experimental Forest

Method of Cutting	Per Cent of Original Stand Removed		Volume Left ^{1/} per acre in board feet
	Basal Area	Board Feet	
	%	%	Bd. Ft.
<u>Virgin</u> 10 acres with practically no yellow birch	0	0	15,910
<u>Virgin</u> 40 acres, 60% sugar maple, 20% yellow birch, 14% hemlock	0	0	14,978
<u>Light Improvement</u> Most defective trees removed regardless of diameter on 7 acres	25	24	10,893
<u>22-inch Diameter Limit</u> Cut confined almost entirely to largest trees on 19 acres	24	29	11,074
<u>Heavy Improvement</u> More drastic removal of defective trees irrespective of size on 8 acres	42	46	7,550
<u>Overmature and Defective</u> All defective and overmature material removed irrespective of size on 10 acres	56	62	5,208
<u>12-inch Diameter Limit</u> Clear cutting of all sawlog timber on 5 acres	80	90	1,572
<u>Clear Cutting</u> Clear cutting of everything merchantable (sawlogs, cord- wood, mine timber, etc.) on 5 acres	97	100	0

^{1/} Computed on basis of Scribner rule. No deductions made for defect.
Cull usually amounts to about 33 per cent in virgin stands in this
vicinity.

It must be emphasized that the study was confined to trees which actually died some time between two consecutive observations. In other words, we made post mortem examinations and not life expectancy predictions.

Before the study began, all trees that were dead were clearly marked so as not to confuse them with trees which died subsequently. In this way we were able to determine the actual mortality that has been taking place under the different degrees of cutting and in the virgin forest, as shown in Table 2.

The striking thing is that in all our true selective cuttings, in which from 24 to 62 per cent of the volume was removed, the average annual mortality was less than $\frac{1}{2}$ of 1 per cent, or about 29 board feet. As the average stand left ranged from 5,000 to 10,000 board feet per acre in these cuttings, it can readily be seen that the mortality has been negligible.

The greatest per cent of mortality, as was to be expected, was found in the area from which all merchantable sawlogs and cordwood was removed. Of course, this loss was not in board feet since there was no sawlog material left. What is most significant, however, and which speaks in favor of selective cutting, is that in the uncut virgin forest the annual mortality was greater than in selective logging, and the average annual loss for the two virgin areas under observation amounted to 140 board feet per acre per year.

But what did the trees die from? Fortunately, the records maintained in the study classified the causes of death. Out of a total mortality in the selective cuttings of less than $\frac{1}{2}$ of 1 per cent, over half was due to trees being broken by the wind. About $\frac{1}{3}$ of the trees lost were uprooted and less than $\frac{1}{5}$ died standing. In other

Table 2.

MORTALITY UNDER DIFFERENT DEGREES OF CUTTING

Method of Cutting	Average Annual Mortality ^{1/} Per acre of residual stand					
	Basal area					
	<u>Sq.Ft.</u>	<u>%</u>	<u>Cu.Ft.</u>	<u>%</u>	<u>Bd.Ft.</u> ^{2/}	<u>%</u>
Virgin (10-acre tract)	.58	.4	17.4	.4	66	.4
Virgin (40-acre tract)	1.14	.9	49.2	1.1	159	1.0
Light Improvement	.22	.3	6.9	.3	27	.4
22-Inch Diameter Limit	.38	.4	12.1	.5	43	.5
Heavy Improvement	.21	.3	6.2	.3	19	.3
Overmature and Defec- tive	.08	.1	2.7	.1	11	.2
12-Inch Diameter Limit	.29	1.0	8.1	1.2	21	1.4
Clear Cutting	.06	1.4	1.3	1.5	0	0

^{1/} In 40-acre virgin tract, no trees were tallied below 9.5 inches D.B.H. In all other cases, all trees 1.5 inches D.B.H. and up were included.

^{2/} Scribner rule.

words, the mortality due to decadence alone amounts to only about 1/10 of 1 per cent, a totally insignificant amount.

Of course, there will be some mortality under any method of cutting. But if a satisfactory growing stock of sawlog material is maintained and mortality is greatly exceeded by growth, then selective logging can certainly be justified. We come now to a consideration of the growth obtained on the cuttings at our Upper Peninsula Station.

Remeasurements after a 5-year period of our sample plots show the average net annual growth--that is, growth in excess of mortality--to be from 2 to 3 per cent or from 160 to 245 board feet per acre per year, as given in Table 3.

In the uncut forest, the net annual growth was determined to be 191 board feet per acre on our permanent sample plot. This may seem to be contradictory to the general assumption that in an uncut virgin forest, growth balances decay. This, however, is the actual figure obtained on our one-acre permanent sample plot and may be explained by the fact that the so-called virgin forest at our Station is not entirely virgin. The white pine was cut out some 30 years ago and within the last 20 years some elm and basswood were taken out. The present stand has, therefore, probably not reached its maximum development. Then, too, it is probable that some of the decay that is taking place in the virgin stand cannot be detected by any visible evidence and does not appear in measurements of growth.

The interesting fact, however, is that the growth on the 12 inch diameter limit cutting (commercial clear cutting), expressed in per cent, was the largest of all, but actually it was only 98 board feet. Although the rate of growth was high, the growing stock had been so depleted by cutting that very little merchantable material

Table 3.

AVERAGE NET ANNUAL GROWTH PER ACRE ON SAMPLE PLOTS^{1/}

Method of Cutting	CUBIC FEET		BOARD FEET	
	Cu.Ft.	Per Cent	Bd.Ft.	Per Cent
Virgin	45	1.1	191	1.2
Light Improvement	81	3.0	235	2.2
22-Inch Diameter Limit	86	2.9	245	2.2
Heavy Improvement	55	2.7	163	2.2
Overmature and Defective	53	3.5	160	3.1
12-Inch Diameter Limit	38	6.4	98	6.3
Clear Cutting	4	6.0	0	0

^{1/} Windfall and other losses deducted, but no deduction for cull. Volumes in board feet computed on basis of Scribner rule for all trees over 9.5 inches D.B.H. Volumes in cubic feet given for all trees over 1.5 inches D.B.H.

was produced on this area. In the clear-cut area, there was no growth that could be computed in board feet. In all other cuttings, the growth in board feet exceeded mortality but it was greatest under selective cutting where a good growing stock was left on the ground.

Does mortality, therefore, constitute a serious handicap to selective logging? Our data, carefully collected over a number of years, say emphatically, NO! On the contrary, selective logging, if properly carried out, can be the means of decreasing mortality and increasing growth by taking out in the first cutting all trees that are likely to succumb in the course of the next 20 to 25 years.